JPRS: 2568

27 April 1960

SCIENTIFIC INSTITUTES OF THE CHINESE PEOPLE'S REPUBLIC

- USSR -

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Distributed by:

OFFICE OF TECHNICAL SERVICES
U. S. DEPARTMENT OF COMMERCE
WASHINGTON 25, D. C.

U. S. JOINT PUBLICATIONS RESEARCH SERVICE
205 EAST 42nd STREET, SUITE 300
NEW YORK 17, N. Y.

JPRS: 2568

CSO: 3648-N

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[This is a translation of an article written by N. P. Luzhnaya in Zhurnal Neorganicheskoy Khimii (Journal of Inorganic Chemistry), Vol. III, No 2, 1958, pages 542 to 545.]

Having spent six months (December 1956 to May 1957) working in the chemical institutes of the Academy of Sciences CPR (Chinese People's Republic), I had an opportunity to familiarize myself rather closely with the scientific work in them, chiefly in the field of inorganic chemistry. More cursory was my acquaintance with the research work being conducted in the chemistry chairs of the higher educational institutions and in the branch institutes.

Although China has only recently begun to coordinate her scientific research projects, much has been achieved in this regard because of the 12-year plan on scientific development which was devised in 1956.

This plan, prepared by a team of China's most eminent scientists, involves 57 separate problems. About 30 of these call for the participation of inorganic chemists. The plan itself is concerned with the major trends in inorganic chemistry, and, at the same time, it seeks to link this branch with the most serious national problems.

Thus most important are those projects which lay a theoretical foundation for the methods of producing, processing, and using the most valuable domestic raw materials which contain scores of different rare elements which are frequently found in quite unusual combinations. Through the active participation of chemists, new types of ceramics, cements, porcelains, and glasses will be created. There is a plan to undertake a wide study of the chemistry of those elements which exhibit the properties of semi-conductors. In addition, plans are being made to establish a school devoted to the chemistry of rare-earth elements which are particularly abundant in China; this school will also seek to develop the chemistry of complex compounds, to develop physico-chemical analysis, and to develop inorganic synthesis. The plan envisions a more intensive course of preparatory study for the inorganic chemistry departments which are, in China, of a rather low state of development.

The Academy of Sciences of the Chinese People's Republic
and its Chemical Institutes

The Academy of Sciences CPR was founded at the end of 1949 from the Peking and Central Academies. Among the Academy's numerous institutes there are six chemical institutes: The Chemical Institute (Peking), the Institute of Applies Chemistry (Chang-Ch'un), The Institute of Organic Chemistry (Shanghai), The Institute of Metallurgy and Ceramics (Shanghai), the Petroleum Institute (Dairen), and the Institute of Chemical Metallurgy (Peking). These institutes are governed by the Department of Physics, Chemistry and Methamics, which is headed by one of the most eminent physicists, the Vice President of the Academy of Sciences CPR, Professor Wu Yu-sung.

There is no trace of a lack of interest on the part of the Academy's directors toward the projects being carried out at any one of its institutes. Thus, during the first half of 1957, the president of the Academy of Sciences of the Chinese People's Republic, Kuo Mo-je, personally familiarized himself with the activities of a number of institutes; he visited each institute several times, he spoke with the professors and students, and inspected the laboratories, libraries, and work shops.

Being present during the President's visit to the Peking Chemical Institute, I bacame convinced of the seriousness and depth of his interest in a field -- chemistry -- which would seem to be so far removed from his own speciality.

An important event in the history of the Academy of Sciences was the General Meeting, which was convened in Peking in the second half of May 1959. The plenary sessions heard and discussed reports from the Presidium and from departments, while various committees heard reports dealing with a variety of sciences. Scientists from most university cities in China were invited to attend this General Meeting of the Academy of Sciences.

I will now turn to a short description of the work done at those institutes and which I managed to visit.

The Institute of Applied Chemistry (Ch'ang-Ch'ung). The Institute maintains five laboratories. The laboratory of organic chemistry (Ouyan Tzuyung) for the most part does research on cellulose -- its structure, methods of production, esterification, and benzedination.

In the high molecular compound laboratory (Prof. Ch'en Pao-kung) rubber is being synthesized and its properties are being studied, especially its mechanical properties. Here they also study the reaction mechanism of the oxidation of organic compounds and the autooxidation of Chinese wood oil and lacquer.

The physical chemistry laboratory studies the catalytic properties of vanadium, and the physical properties of high molecular compounds. Here they study problems of kinetics and the theory of

solutions (Prof. T'ang Ao-ch'in). Much work is being done on emission and absorption spectral analyses (Prof. Ch'ang T'ing-ch'ao).

The analytical chemistry laboratory analyzes the rare-earth elements by means of ion exchange resins; methods are also being developed here for the analysis of molybdenum, mercury, tungsten, and other domestic ores (Chenki).

A study is also being planned of the application of complex compounds and masked media; work on the physicochemical analysis of complex compounds in solution is also planned.

Vice President Yuan Hsiu-sheng developed a highly refined method for the determination of calcium in the presence of a high magnesium content.

The inorganic chemistry laboratory has several projects going. Professor Sh'en Ch'ing-nan is doing work on the electrochemistry of melted salts in order to provide a basis for the electrochemical methods of producing pure metals.

Much work is being done on the application of the polarographic method, involving the use of a rotating platinum electrode and an oscillographic polarograph of the Ciyerovskiy type.

Prof. Yuan Hung-i's group is developing the scientific basis for the methods involved in the processing of vanadic ilmenite and is doing research on the phase diagram TiO_2 - CaO - FeO at high temperatures. The phase changes of diaspore and bokemite* are also being studied in order to obtain aluminum oxides which are easily dissolved in alkali.

The Vice Researcher Tzun Huan-ban has his group working on the chemistry of rare and scattered elements. A number of his associates are working on problems in electrochemistry and corrosion (Vice Researcher Chou Jung-chao).

The Chemical Institute (Peking). This institute was founded only about two years ago; it is a complex of chemical institutes and has five divisions, similar to the five laboratories of the Institute of Applied Chemistry. Although the external structure of both institutes is identical, the projects undertaken in each and the direction which these projects take is quite different and act to complement one another.

The Organic Chemistry Department is headed by Prof. Su Ze-heng and here are conducted projects on the catalytic hydrogenation of acetylene and carbonyl compounds; work is being done on the addition of a cyanoethyl radical, on the oxosynthesis of acetylene compounds, on the synthesis of nitriles, and on the study of the change mechanism in chlorodivinyl. The elementary organic compounds of fluorine, sulphur, and phosphorous are also being studied.

In the Department of High Molecular Compounds, which is headed

*Translator's note: Available references do not list this mineral (transliterated).

by Prof. Wang Pao-jen, four separate projects are underway: 1) the reaction mechanism of polycondensation; 2) the mechanism and kinetics of polymerization; 3) the physical chemistry of high molecular compounds (the determination of molecular weights); 4) the synthesis and properties of ion exchange resins.

Polymerization processes are studied for various vinyl compounds; here are studied the mechanism of emulsion polymerization and the polymerization of a caprolactam by means of plotting the molecular weight distribution curves during heating to 230°.

A series of projects on the methods of determining molecular weights is being carried out under the direction of Prof. Cheng Jen-yuan who was awarded the prize of the Academy of Sciences CPR for 1956.

Prof. Lin I is conducting research on sulphur-organic and fluoroorganic compounds.

The structure of Chinese lacquer is also under study.

The Department of Analytical Chemistry is headed by Professor Liang Shu-ch'ang who is working on the development of an analysis method and a method of separating rare earths found in the iron ore at Pao-T'ao; this department is also working on the development of methods to determine microquantities of fluorine in the air. Chromotography is being applied in these projects, as is polarography, ion exchange, spectrophotometry, and extraction by means of organic solvents.

The Department of Physical Chemistry is doing research on the phenomena of adsorption, the colloidal properties of clay in suspension, and the effect of electrolytic additives on these properties, as well as the ion exchange capacities of bentonites (Prof. Fu Ying). A group dealing with thermodynamics is working on problems having todo with the theory of solutions (Prof. Huang Tse-ch'in) as well as on the design of a calorimeter which will function at high temperatures (to 1200°) and a mocrocalorimeter for the determination of thermal effects of gradual processes (the heats of adsorption, the reactions of high molecular compounds, etc.) (Prof. Hu Jih-heng).

A group on catalysis is studying catalytic activity as a function of the properties of the carrier (Al_2O_3) in the case of active catalysts (Ni, for example).

The Department of Inorganic Chemistry is made up of four groups. A small group, headed by Vice Researcher Liu Ch'en-i is working on the chemistry of complex compounds of rare earth elements; this study is intended for the development of a method to separate these elements and to study their properties. The group which is concerned with stable isotopes is doing its work under the direction of Professor Chang Ch'in-lien who is, at the same time, director of the department of inorganic chemistry at Peking

University. Greatest attention is devoted to the study of the properties of water containing heavy hydrogen, as well as to the processes of thermal diffusion.

The group concerned with crystallochemistry is headed by Professor Tan Yu-chin. Here structures of organic and inorganic compounds are studied.

The group under the direction of Professor Liu Ta-kang is doing research on lakes and deposits of salt in China. They are studying the processes of isothermal evaporation of the brine from the lakes in those regions where we find the high-mountain salt lakes of Tsaydam.

Physicochemical analysis is used to study the equilibrium of salts in solution and in melts. The study of tertiary and quaternary systems of chlorides of alkali and alkaline-earth metals has been started; these methals are typical in the salt deposits of China.

The Institute of Metallurgy and Ceramiss (Shanghai) is one of the oldest institutes in the country (founded in 1929). It has three large departments: a department of silicates, a department of chemical metallurgy, and a department of the physics of metals; in addition, there are two laboratories -- an analytical laboratory and a technological laboratory.

The Department of Silicates is headed by Professor Yeng Tung-hsing and is involved in the study of glass, ceramics, and refractory materials. Glass containing Boron is studied here; there are plans to undertake a study of glass containing phosphorous. This department is well equipped with modern machinery, thus making it possible to conduct research on a great number of glass properties.

The director of the Institute, Professor Chou Jen, is concerned with Chinese porcelain and he has collected a unique array of antique porcelain; he has created new types of porcelain which are of as good a quality as any produced by the Chinese masters.

Here corrosion and refractory properties of a number of materials in a Hydrogen Fluoride atmosphere and in molten glass and slag are also being studied. Professor Yien is studying the systems containing oxides of titanium, silicon, aluminum, iron, and calcium.

The Department of Chemical Metallurgy is headed by Professor Chou Yuen-hsien. The ores of Pao-T'ao are being studied by the department of ferrous metallurgy. Theoretical work is also being done on the determination of the slag activity in synthetic specimens and in Pao-T'ao ores. The department of steel metallurgy is studying the effect of small cerium and lanthanum additives on the solubility of hydrogen and nitrogen in steel. Work is also being done on the metallurgy of light and rare metals.

The Department of the Physics of Metals (Prof. Wu Chin-liang) is researching the effect of Boron on the phase conversion of metals;

the physical and mechanical properties of alloys and the processes of powder metallurgy, are studied here in addition to the X-ray research on metal alloy structure.

The Institute of Chemical Metallurgy (Peking) is headed by Professor Yeh Tu-pieh. This organization is concerned with the problems of applying chemical technology to metallurgical processes. The institute does not yet have its own quarters and is working on the preparatory projects for its assignment -- the intensification of metallurgical processes and the study of the kinetics and mechanisms of the most important reactions.

Five different courses are being planned -- the study of those processes which take place in household smelting, annealing in the rim layer, the study of the phenomena which take place at the surface of the layer, the hydrometallurgy of Ni, Co, Cu, Al, etc., and Bessemer steels in a hydrogen atmosphere.

The Chemical Chairs of Higher Educational Institutes

I had the opportunity to familiarize myself directly with the work of the department of inorganic, and to some extent, the department of physical chemistry at the Universities of Peking, Funda, Dumbey, Nanking and Chetszyan; I was also able to familiarize myself with the 1957 plan for nine chemical faculties of a number of universities in which there are inorganic chemistry departments (the Universities of Nanking, Amoy, Shandun, Sychuan, etc.).

The wealth and variety of methods, the abundance of interesting theoretical problems, etc., prove that the scientists at the higher educational institutes of China have made a tremendous contribution toward the successful completion of the tasks set by the 12-year plan for the development of science in the country.

Thus, for example, at Peking University, in the chair of inorganic chemistry headed by Professor Chang Ch'in-lien, they study stable oxygen and hydrogen isotopes, they determine the solubility of slats in heavy water and in mixtures of heavy and conventional water. They are studying the process of ion exchange separation of praseodymia and neodymia from Chinese resins as well as the extraction of molybdenum from tungsten ores; they are studying solubility in a number of systems of chlorides and sulphates of rare elements.

Professor Huan Tse-ch'ing of the chair of physical chemistry is doing some interesting work on the theory of solutions, studying the effect of desalination by means of large ions.

They are doing work on the structures of inorganic compounds (Prof. Tang Yu-ch'in) of boron and silicon; they are doing work on the structures of annumber of complex compounds, sulphides,

selenides, and tellurides of the elements of the fifth group.

Professor Shyu K'uang-hsien is doing work on the processes involved in the formation of potassium ferrocyanides with ions of a number of metals, oxalates of alkali and alkaline-earth metals; he is also doing work on the determination of dissociation constants for nitrophosphoric acid and the stability of comples ions of this acid with metals.

At the University of Fudan, under the direction of Prof. Yien Ch'in-sheng, projects are being carried out to study complex halogenides and rodanides of cadmium; extraction methods involving a large number of organic solvents are being developed here. Complex compounds of Fe, Ni, and Zn, and the derivatives of oxyquinoline are studied here. The mechanism of the decomposition of a hydrogen peroxide complex is also studied here.

In the field of rare element chemistry extraction methods for Nb, Ta, W, V. Mo, and Ce from domestic raw materials are being developed as are processes for the separation of rare earths by the ion exchange method. These projects are under the direction of Professor K'u I-tui who has many associates and students working under him at the present time. Chromotography, extraction, ion exchange, etc., are all widely used.

Under the direction of the Soviet specialist, Prof. P. S. Bogoyavlenskiy, solubility in a number of melted salts and in systems in which salts are dissolved in water are being studied.

At the University of Nanking, in the chair of inorganic chemistry, headed by Professor T'ai An-p'an, they are conducting studies of coordinated compounds of hydroxytartrates of calcium and tartrates of copper; they are also studying the processes involved in the formation of complex polyvalent cations with tungsten, and they are studying the polymerization processes in gelatinous silicic acid. They study ions of Cr, Ca, Fe, Al, Zr, etc., in a state of solution by using methods involved in the formation of complex compounds and by studying their polarization and capacity for colloidal precipitation.

The chair of physical chemistry, which is headed by Professor Li Fang-hsing, is doing work on the determination of the qualitative relationship between the solubility of electrolytes, and on deriving a theory of concentrated solutions. The solutions which contain some salts are used to study the phenomenon of electro-capillarity, vapor pressure, activity, electromotive forces, and solubility.

Branch Scientific Research Institutes

There are many, large and well-equipped branch institutes in China; these institutes work, to some extent, in all the fields of inorganic chemistry. There are also extremely large chemical laboratories situated in large industrial plants, and these laboratories follow their own research program. Unfortunately, I was only able to visit three such installations.

The Institute of the Chemical Industry (Shanghai) is doing work, for the most part, in the chemistry of mineral fertilizers. Potassium fertilizers are being studied by the Research Engineer Chang T'ao. This work was begun some 10 years ago, but it was not carried out systematically. Alunite is the subject of the greatest study. The institute suggested a complex processing method for alunites, which would yield potassium fertilizers in the form of solid solutions of K_2SO_4 and $(NH_4)_2SO_4$ and of aluminum in the form $Al(OH)_3$. They also suggested work on potassium salts dissolved in water.

With regard to nitrogen fertilizers, most of the work is related to the study of the processes of removing damaging impurities from coke oven gas. Work is being done on the production of ammonium sulphate by means of phosphogypsum instead of natural gypsum (Engineer Sun T'i-sao).

In the field of phosphorous fertilizers the processes of enriching domestic phosphorite (Tzinbin apatite, Kuimin phosphorite) by means of magnetic and gravitational flotation has been under study. Work is being done on ore decomposition, through the use of nitric acid; corrosion processes (due to alkali) in industrial equipment are also being studied. The processes involved in the defluoridation of phosphorite through the use of water vapor (Engineer Wang Pao-he) are also undergoing study.

The Institute of Nonferrous Metals (Peking). This institute has four laboratories: one for the processing of alloys, one metallurgy laboratory, including the pyrometallurgy of nonferrous metals, another for enrichment, and one for analysis. The institute has many instruments and much equipment, and it has its own test installation.

A study is being planned of a system of rare metals. Powder metallurgy is coming to the fore. Work is being done on the extraction of a number of rare elements from ores by means of hydrometallurgical methods, by means of the application of ion exchange resins, and by means of electrolysis for the purpose of separating the rare elements.

A scientific research laboratory doing work on the production of salts is located at the large salt mines near the city of Tangu where salt is obtained from sea water. The mine is over 2000 years old. After liberation the mine was expanded and reconstructed;

test pools were built, and a large 64-man scientific research laboratory was set up; this laboratory is under the direction of Engineer T'eng Wei-kang.

The research laboratory headed by Engineer Liu Te-wang is doing work on clarifying the effect that the metamorphization factor for brine might have on the yield and quality of salt. Engineer Liu Shao-t'un has worked out an original method of processing the mother liquor after the removal of the NaCl by means of adding a waste calcium chloride solution which is kept close to the soda plant for the removal of the SO_4^{2-} ion.

In conclusion it should be noted that a comparison of current projects in the field of inorganic chemistry in China with the state of these projects in the past is provided in a review by Corresponding Member of the Academy of Sciences USSR I. V. Tananayeva who visited the CPR two years ago; this comparison shows the Chinese forces have attained great achievements both in the area of expanding their methodology and in the number of subjects under study; they have also done much along the lines of expanding the number of projects.

The perserverance, persistence and energy of the scientists of the CPR bear witness to the fact that the problems of the 12-year plan for the development of science will be solved successfully.

END

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of the various government departments.